HANDBOOK

ENVIRONMENTAL CONTROL SYSTEM
GENERAL DESCRIPTION AND OPERATION

Approved For Release 2005/04/21 : CIA-RDP75B00285R000400120002-3

INTRODUCTION:

This handbook describes equipment for which The Firewel Company has been responsible in this environmental control system program. This includes the full pressure suit, the suit-mounted pneumatic and oxygen-controlled equipment and ship-mounted pneumatic and oxygen-controlled equipment.

The suit system, together with the conditioning system, will maintain thermal and respiratory balance for the pilot and provide emergency protection against extremely high temperature, wind blast and decompression. During normal flight the suit is not pressurized and not restrictive to movement. The suit ventilation system maintains comfort under the gas-tight and insulated clothing assembly. If a decompression situation should occur, the suit offers complete pressurization while ventilation and thermal protection continue unchanged. Movements will be somewhat limited when the suit is pressurized but not enough to hamper necessary actions of the pilot.

Due to the duration of the proposed normal mission, the normal oxygen supply is sufficient to support a flight of four and one-half hours going 'OUT' on two oxygen supply cylinders and return on 'ONE' oxygen supply cylinder.

In accordance with overall program philosophy, a basic design concept has been complete duality of function. This includes the dual breathing regulator, dual suit controller, complete duality in the panel-mounted oxygen control unit, ships oxygen supply as well as support hardware such as disconnects, lines, controls and emergency oxygen supply.

A special seat kit is provided to give forward leg support to the pilot due to the forward seated position necessary because of the parachute and emergency oxygen supply back pack. The seat kit will contain only survival equipment.

SHIPS OXYGEN SYSTEM
General Description and Operation Instructions

Oxygen Control Panel Assembly:

The ships oxygen control panel assembly is mounted at a convenient location on the L.H. cockpit console. The panel, completely dual, consists of two oxygen supply 'ON-OFF' valves and two low pressure gages enclosed in a single housing.

The 'ON-OFF' valves provide flow/no flow control of the ships supply of oxygen from the oxygen supply cylinder-reducer assembly through suitable tubing to the ships quick disconnect. The 'ON-OFF' valves also provide the crew member with a secondary oxygen supply depletion-balance control; i.e., if one of the supply cylinder shows an excessive depletion rate, as compared to the other supply cylinder, the reducer in the rapidly depleting system can be turned off until the pressures in both systems are equal. The primary depletion control is automatic, but may vary due to some slight mechanical condition.

The low pressure gages, connected independently to the low pressure, outlet side of the high pressure reducers, provides a direct reading of the oxygen pressure delivered to the helmet regulator.

Oxygen Disconnect Assembly (Dual):

Oxygen from the ships supply is conducted through the 'ON-OFF' valves to the ships disconnect. The disconnect is mounted at a suitable position on the front of the crew member's seat, permitting ease of personal oxygen hose attachment and allowing vertical seat adjustment.

Attachment of the personnel oxygen leads (hoses) to the oxygen disconnect assembly is accomplished by simple alignment of the leads to the disconnect and pressing into place. Engagement of the leads into the disconnect mechanically locks them into this position and automatically opens a check valve in the disconnect allowing the oxygen to flow to the suit controller. This check valve cannot close and cut off oxygen supply except by separation of leads from the disconnect. Manual disconnect separation can be accomplished by pulling 'UP' on the oxygen leads. (A pull of approximately thirty pounds is required)

The disconnect is also equipped with a lanyard operated separation mechanism. By attaching the lanyard to convenient aircraft structure, the ejection of the seat

during emergency aircraft abandonment will automatically separate the crew member from the oxygen disconnect and ships oxygen supply. Check valves incorporated in the crew members personal oxygen leads automatically close to prevent loss of emergency oxygen through the separated leads. The ejection bailout action reacts upon a guided cable to the emergency oxygen system causing the emergency oxygen to be turned on providing the crew members with an uninterrupted supply of oxygen.

NOTE: Emergency abandonment during flight: First - manually pull the green apple.

High Pressure Reducer:

The two high pressure oxygen reducer valves, connected independently to the oxygen supply cylinders, reduces the outlet pressure of the supply cylinders from the stored pressure of 2000 PSI (maximum) to a delivery pressure of 66 PSI at 100 LPM flow. Flow passages and arrangements of internal parts are such as to maintain delivered pressures without appreciable pressure drop during any conditions of demand, including maximum obtainable flow volume of the helmet breathing regulator.

Relief Valve:

A spring-loaded relief valve is installed on each reducer. Its function is to prevent excessive pressure buildup in the system due to leakage across the reducer valve when the system is not in use. The valve is set to relieve at a pressure between 120-140 PSIG.

Burst Disc:

A safety burst disc is incorporated in the outlet port of the oxygen supply cylinder. The burst disc serves as a maximum pressure relief valve to prevent a hazardous pressure buildup in the supply cylinders due to an abnormally high temperature condition.

Dual Pressure Gage, High Pressure:

The dual high pressure gage is connected independently to the inlet side (high pressure) of the oxygen high pressure reducers and provides a direct reading of the pressure of oxygen stored in the supply cylinders.

The dual high pressure gage is enclosed in a single housing and is mounted on the left-hand cockpit instrument panel.

Warning Light, Depleting Oxygen Supply Pressure:

Two warning lights (red) connected through two pressure-sensitive switches to the oxygen supply cylinders will turn on the warning lights whenever the stored oxygen pressure in either cylinder decreases to 400 psig.

The warning lights are mounted on the main instrument panel in the cockpit.

Bottle Assembly, Oxygen Supply:

The oxygen supply is contained in two non-shatterable steel cylinders with a single cylinder volume equal to 875 cubic inches (1750 cubic inches total capacity, two cylinders) and a service pressure of 2000 psi at 70°F.

Ventilation Control Valve:

Thermal protection is provided by the controlled flow of ventilation gas through the suit. The ventilation control valve, mounted on the left-hand console, is a variable flow valve enabling the pilot to manually adjust the flow of ventilating gas from the ships supply to the suit.

Ventilation Disconnect Assembly:

The ventilation disconnect, an integral part of the vent system, is mounted on the crew member seat and provides automatic separation from the suit vent system. Vent system separation occurs automatically during pilot normal 'stand-up' movements for ground emergency evacuation and automatic lanyard controlled separation occurs during in-flight emergency seat ejection. A check valve is incorporated in the suit half of the disconnect to prevent loss of suit pressure at disconnect separation and also acts as a water check valve.

PERSONNEL OXYGEN EQUIPMENT

Suit Controller, Dual:

The suit controller is a combination high flow low resistant valve provided to regulate and maintain suit pressure. The vent section of the valve uses a compensated diaphragm and aneroid controlled back pressure to maintain absolute suit pressure.

The suit controller, mounted on the R.H. side of the suit, is a completely dual unit enclosed in a single housing.

Operation:

The controller automatically maintains a constant absolute suit pressure of:: Primary system - 180 mm. Hg. -- Secondary system - 170 mm.Hg.:: subject to variations in pressure permitted for ventilation and allowable suit leakage, whenever an atmospheric pressure of 170 mm. Hg. or less is reached. The controller maintains the necessary suit pressure by controlling the back pressure of the ventilating gas. If the vehicle ventilating gas supply system becomes inadequate or is lost, the demand section of the suit controller will automatically supply gas pressure directly into the suit from the oxygen supply system. The normal aircraft oxygen supply and the emergency supply systems are connected to the suit controller to insure suit pressurization under all flight conditions.

A water check valve is provided in the controller to prevent the flow of water into the suit when submerged in water.

Oxygen Flow Tester (Press-to-Test):

The oxygen flow tester is an integral part of the suit controller. It can be readily reached with either hand and is so designed to minimize its unintended operation by hand or arm movements.

The manual oxygen flow tester enables the crew member to in-flight or ground check the suit controller operation. The press-to-test is activated by pressure of the crew man's finger; the result of this action is to create artificially a demand condition within the controller corresponding to that which would be encountered at high altitude. The action causes suit pressurization and a corresponding increase in oxygen flow to the helmet regulator.

Oxygen Breathing Regulator, Dual:

The breathing regulator, mounted inside the helmet, is a dual demand type regulator actuated by a spring-loaded diaphragm that is referenced to the suit pressure to maintain a positive breathing pressure over any given suit pressure. The regulator supplies the pilot with breathing oxygen from the ships system during normal operation and from the emergency oxygen supply during any emergency requirements.

A variable orifice is incorporated in the dual regulator to facilitate equal depletion of the dual ship supply or dual emergency supply of oxygen.

Exhalation Valve, Dual:

The exhalation valve is a spring-loaded one-way valve referenced to suit pressure allowing the exhaled gas to escape from the face area into the suit.

Emergency Oxygen System:

The completely dual system, enclosed in one compact unit, is located in the parachute pack. This system is connected to the crew member at the suit controller.

The system consists of two groups of oxygen supply cylinders containing 60 cubic inches volume per group (120 cubic inches total volume, both systems) at a stored pressure of 2000 PSIG maximum. Two high pressure reducers, two high pressure gages and associated release cable mechanism.

Emergency Oxygen System Operation
Emergency In Flight:

Several situations might bring about the emergency. A prolonged flight at high altitudes could dangerously deplete the ships supply of oxygen. This would require switching to emergency oxygen, pull the 'green apple' while descent to a lower altitude is accomplished.

The 'green apple' is located on the front, left hand side of the suit, elbow height.

Grasp the 'green apple' firmly with the right hand and abruptly pull from left to right out of its retained position.

Emergency Bailout Operation:

When emergency abandonment of the aircraft at high altitudes becomes necessary, the emergency oxygen system is brought into use as abandonment takes place. Activation of the emergency oxygen supply and separation from the aircraft oxygen leads takes place automatically. Automatic activation of the emergency oxygen supply is accomplished by means of a lanyard which is connected to the emergency supply 'ON-OFF' reducers and to the aircraft structure.

The crew member is thereby provided with an uninterrupted supply of oxygen for breathing and suit pressurization.

Check valves incorporated in the crew members personal oxygen leads close to prevent loss of emergency oxygen through separated disconnects.

NOTE: Although automatic activation of the emergency oxygen system has been provided, the crew member should always, before aircraft abandonment, manually pull the 'green apple'.

System Operation Test:
Press-to-Test:

The oxygen flow tester, 'press-to-test' assembly, provides a suitable and readily accessible means of testing the complete pilots personal oxygen system for correct operation. By pressing the press-to-test button, located on the suit controller, the aneroid reference passage to ambient atmosphere is closed, thus simulating the conditions of oxygen flow which would be encountered during high altitude non-pressurization during flight, or during high altitude bailout.

When the press-to-test buttons are pressed and the oxygen system is functioning properly, the crew member will sense the pressurization of his suit within seconds.

Press-to-Test Procedure:

1. Press the LEFT press-to-test button, primary system, suit pressurization will be sensed.

2. Press the RIGHT press-to-test button, secondary or backup system, suit pressurization will be sensed.

OPERATION CHECKOUT KIT:

A compact operational checkout kit is provided to functionally test the suit pressure, suit leakage, helmet differential pressure and ships oxygen supply pressure. This ground-level check can be accomplished at the aircraft as a pre-flight item or as a normal maintenance procedure.

PROGRAM INDOCTRINATION
TRAINING MANUAL

December 12th, 1961

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INTRODUCTION:

This preliminary training session has been established to familiarize you with the program oxygen equipment, both personal and ships systems. A more comprehensive coverage of this subject will be available to you at a later date (See Section II of this booklet).

A classroom indoctrination will be used to give you a detailed description of the complete system.

A short altitude chamber run will be conducted using only a full pressure suit helmet, to demonstrate the system under minimum altitude conditions. During this chamber run, at 27,000 feet altitude, you will be breathing from the regular ships oxygen system and the emergency oxygen system.

Personnel Conducting this Program will Be:

STAT [redacted]

--- Program Director
--- System Design & Test Engineer
--- Altitude Chamber Chief
--- Program Field Coordinator

PROGRAM TRAINING AGENDA:

FIRST DAY:

A.M.
9 to 11:30

INDOCTRINATION:

1. System Familiarization [redacted] STAT

   A. General description of the complete system.

   B. Review Manual on system description and operating instructions

   C. General discussion using component parts, suit, emergency system and schematic prints.

P.M.
1:30

2. Detail Functions of System Operation

   A. Suit

   B. Suit--Helmet

   C. Describe conditions during system normal operation (no-pressurization), emergency conditions (suit pressurized)

STAT

SECOND DAY:

A.M.
9:00 — Test Equipment Familiarization [redacted]

A. Chamber

B. Instrumentation

10:00 AM — Altitude Chamber Run:

A. 30-minutes at 27,000 feet using ship system

B. 30-minutes at 27,000 feet using emergency system

P.M.
1:30 — General Review of Complete System [redacted]

STAT

TRAINING COMPLETED

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In Section II of this booklet you will find an outline of the Training Program that will be provided at a later date.

SECTION II

PROGRAM INDOCTRINATION TRAINING MANUAL

PROGRAM INDOCTRINATION
TRAINING MANUAL

November 27th, 1961

STAT

INTRODUCTION:

This training session has been established to familiarize you with the program oxygen equipment, both personal and ships systems.

A total of six days will be used for this training course. Two days will be spent in classroom indoctrination: the remaining time will be spent in the altitude chamber simulating various flight conditions.

A detailed agenda is listed in Section 4.

The 'Classroom Indoctrination' will be used to give you a better understanding of the equipment you will be using.

The 'Altitude Chamber Runs' will give you actual experience and establish your confidence in the system as you are exposed to simulated flight conditions.

To help reassure you, the equipment, the suit the chamber and your crew have been through this exercise many times before: SUCCESSFULLY, I might add.

_____ will be the Training Coordinator and _____ serves as your Crew Chief during the chamber runs.

TABLE OF CONTENTS

1. PURPOSE:

To provide the user with preliminary training and background information on the environmental system.

2. SYSTEM DESCRIPTION:

The environmental control system consists basically of a full pressure suit for altitude and high temperature protection, in addition to the oxygen systems, both ship and emergency.

3. TEST FACILITIES:

3.1 Equipment:

3.1.1 Altitude Chamber with Heat Chamber mocked up to simulate shipboard oxygen system

3.1.2 Bio-Medical Checkout Equipment

3.1.3 Emergency Oxygen System

3.1.4 Assorted flow and pressure measuring instruments

SECTION 4
PROGRAM TRAINING AGENDA 11-28-61

First Day:

STAT

A.M.
9 to 11

Indoctrination:

1. System Familiarization: [redacted]

STAT

1.1 Ship System
1.2 Suit System
1.3 Ground Support Equipment

2. Test Equipment Familiarization [redacted]

2.1 Chamber

2.2 Instrumentation

2.2.1 Altitude
2.2.2 Oxygen Consumption
2.2.3 Vent Supply
2.2.4 Temperature Recording
2.2.5 Medical Instrumentation

2.2.5.1 Rectal Probe
2.2.5.2 EKG Patches
2.2.5.3 Body Temperature Pickups

2.3 Test Procedure

2.3.1 Normal
2.3.2 Emergency

P.M.
1 to
4:30

Two-Hour Run with Full Pressure Suit:
Suit checkout

1. One-half hour at 27,000 feet
2. One-half hour at 35,000 feet
3. One-half hour at 27,000 feet

Check back pressure vs. ventilation on suit at ground level, 27,000 feet and 35,000 feet.

Subject will use 'Press-to-test' at both altitudes for familiarization and comfort.

Second Day:

A.M./P.M.
7 - 5:30 Eight and One-half Hour Run (Full Oxygen Ship System)
Full time at 27,000 feet with heat per attached Graph Number 1.

STAT

Third Day:

P.M.
1 - 4:30 Indoctrination:

1. Review of Second Day Run:

Briefing on high altitude/high temperature test to be performed on fourth day.
(i.e., flight profile, use of emergency oxygen system)

Fourth Day:

8:30 am to 1:30 pm

High Altitude/High Temperature:

Full ship system
Bottles charged to _____PSI.

1. One-half hour at 27,000 feet. (Heat/Graph Number 1)

2. One-quarter hour at maximum altitude (Heat as on Graph Number 1) Vent off.

3. One-half hour at 27,000 feet (Heat/Graph Number 1)

4. Rapid ascent to 55,000 feet. Hold for one quarter hour. (Maximum heat all over box wall - 500°F) Vent off.

5. Descent at 10,000 feet per minute to 27,000 feet. Hold for one-quarter hour. (All heat off) Vent on. Cooler on.

6. At 27,000 feet send in Emergency Oxygen System. (All heat OFF)

7. Rapid ascent to 60,000 feet. (All Heat OFF) Ship Oxygen Supply OFF. (Emergency Oxygen ON)

8. When Emergency Oxygen gages show 300 PSI (highest system) start descent to ground level. (All heat OFF) (Ship Oxygen Supply OFF) Emergency Oxygen ON

STAT

Fifth Day:

A.M./P.M.
8 - 4:30

Indoctrination Training:

Detail functions of system.

Briefing on run to be made on Sixth Day.

Sixth Day:

A.M./P.M.
7 to 5

Eight and One-half Hour Run:

1. Four and one-quarter hours at 27,000 feet (Heat per Graph Number 1) Full Ship Oxygen System, except Chamber air temperature will be held to 100°F.

2. Four and one-quarter hours at 27,000 feet (Heat per Graph Number 1) Chamber temperature will be held to 100°F. One-half Ship Oxygen System.

BASIC PROCEDURES:

1. Subject will pre-breath pure oxygen for ONE HOUR prior to the chamber run.

2. During test, subject will read out ship system gages every ten minutes for the first hour - every fifteen minutes thereafter. Emergency oxygen gages, when this system is used, will be read every five minutes.

3. Standard rate of ascent and descent will be 10,000 feet per minute.

4. No in-flight feeding is planned unless requested by the subject.

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TIME	PULSE	RECTAL	SKIN TEMPS. HIGH/LOW	REMARKS

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DEPLETION DATA

Time _____ Start dressing Date _____

Recorder _____

Subject _____

Suit Pressure _____ mm.Hg. at _____ LPM Vent flow _____ "H_2O Diff.

Suit Pressure _____ mm.Hg. P.T.T. Number 1 _____ "H_2O Diff.

Suit Pressure _____ mm.Hg. P.T.T. Number 2 _____ "H_2O Diff.

Time _____ On Chamber O_2 _____ PSI No. 1 _____ PSI No. 2

TIME Elapsed	TIME Actual	Sys. 1	Sys. 2	Suit Press.	Alt.	COMMENTS

BACK PRESSURE vs FLOW
DATA SHEET

Full Pressure Suit No. S-901

Subject_____

Test Conductor_____ Date_____

GROUND LEVEL BENCH TEST using 'Vol-O-Flow' meter. Suit only without subject, helmet and gloves OFF.

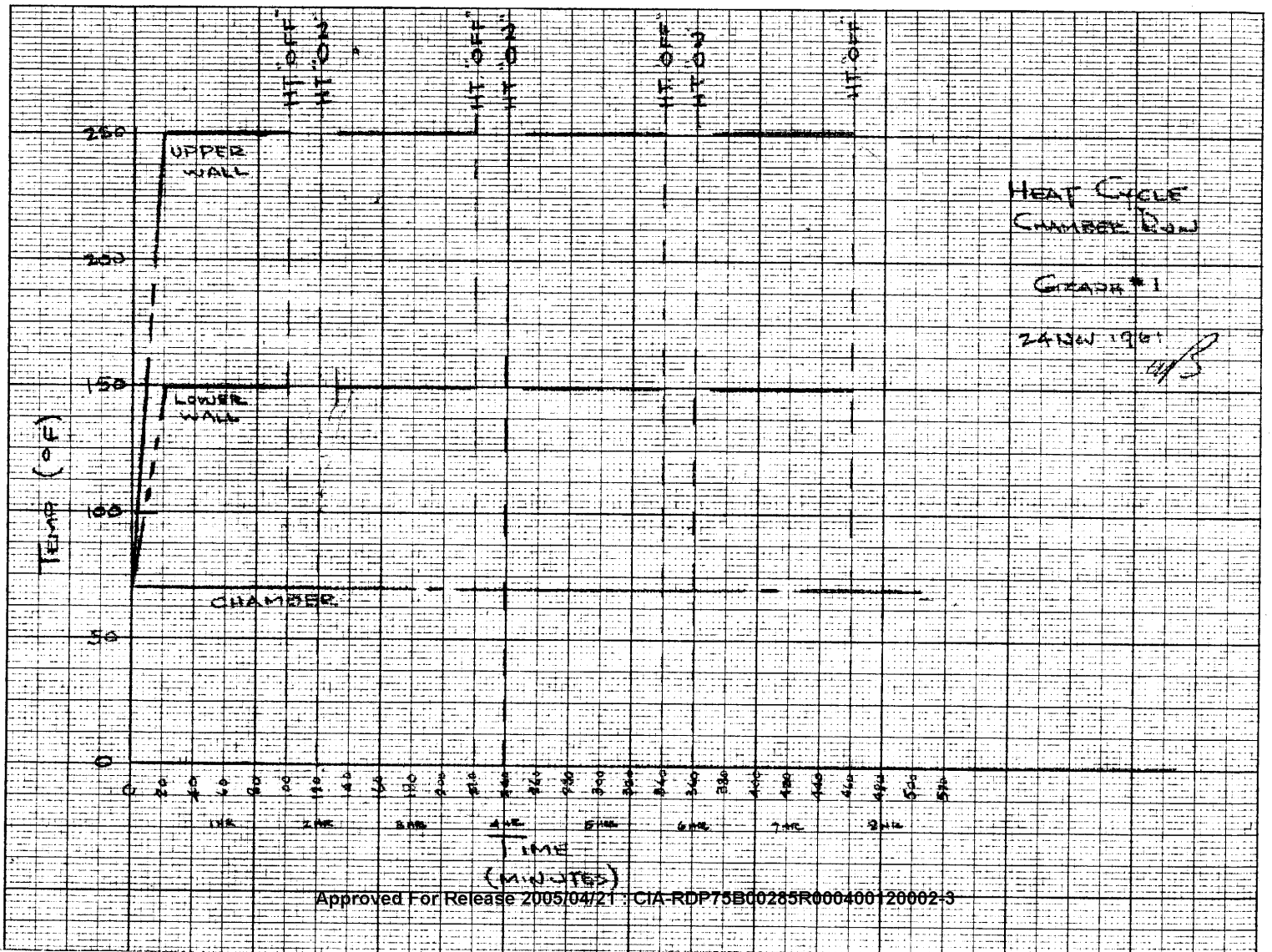
FLOW RATE (L.P.M)	BACK PRESSURE VENT AIR, SUIT (" H_2O)
190	
280	
350	

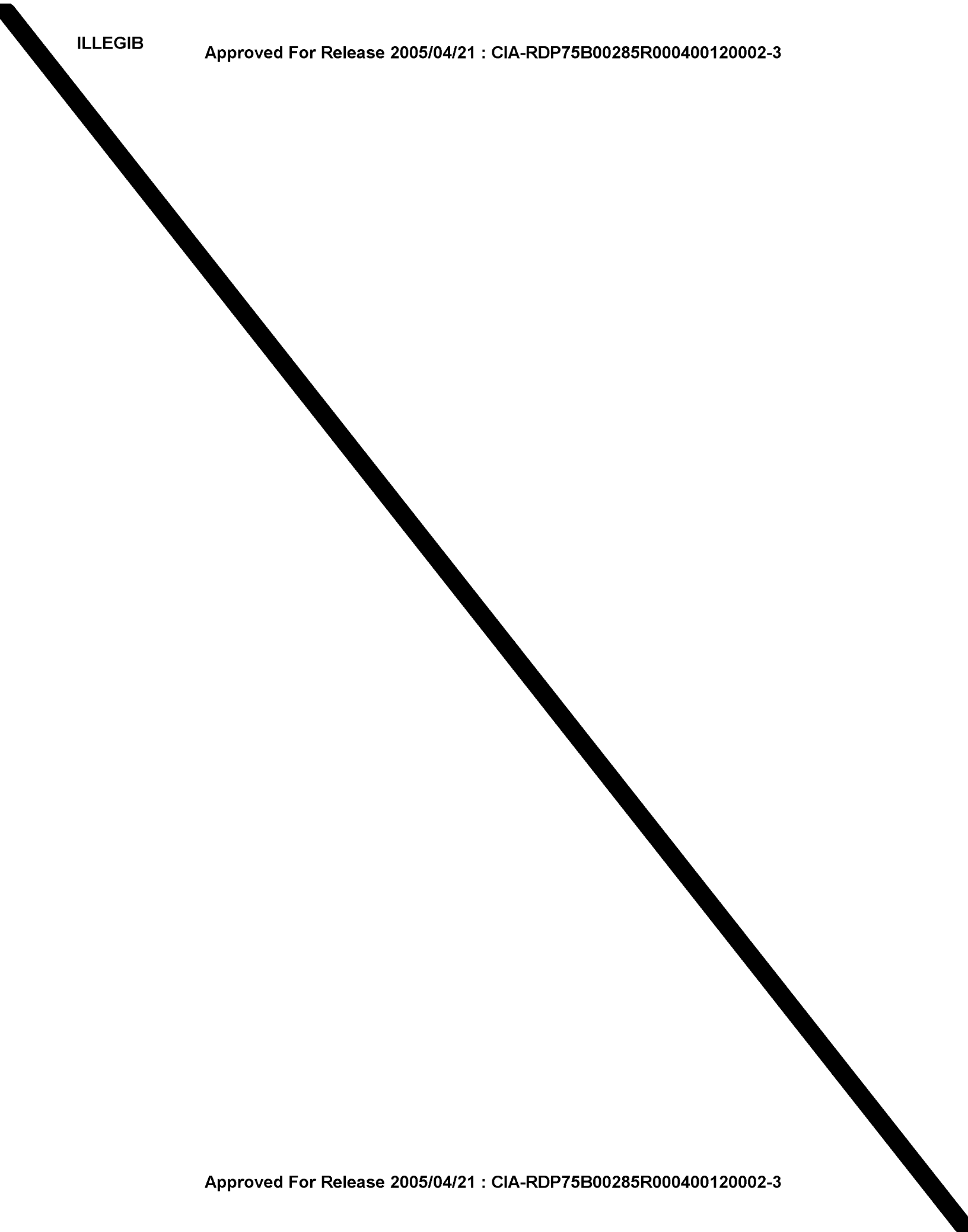
GROUND LEVEL - Subject fully suited: Visor closed.

FLOW RATE (L.P.M)	BACK PRESSURE VENT AIR, SUIT (" H_2O)	
	Standing	Sitting
190		
280		
350		

ALTITUDE CHAMBER TESTS - Subject fully suited, visor closed.

FLOW RATE (L.P.M)	BACK PRESSURE, VENT AIR, SUIT (" H_2O)			
	Ground Level		27,000 Feet	35,000 Feet
	Sitting Only	Flight Hookup	Flight Hookup	Flight Hookup
190				
280				
350				





TRAINING MANUAL

Firewel